Rolls-Royce Industrial Spey

Outlook

- Production has ceased
- No plausible market opportunities exist at this time
- MT30 Marine Trent has taken up market for this turbine

Orientation

Description. The Spey is a two-shaft, axial-flow, aeroderivative industrial and marine (I&M) gas generator and gas turbine engine in the 20-MW class.

Sponsor. The original aero Spey engine was privately developed by the prime contractor.

Power Class. For marine propulsion duty, the I&M Spey delivers up to 19.5 MW (26,150 shp) continuous.

Status. Production ceased in 2006.

Total Produced. At the start of 2016, approximately 180 I&M Spey gas generators and machines had been installed.

Application. The current application of the I&M Spey is marine propulsion. The Spey has been used for mechanical load drive duty and by the pipeline and process industries.

Price Range. $7.2 million for a marine propulsion package (estimated in 2015 U.S. dollars).

Competition. In the marine power sector, the R-R I&M Spey faces competition from the Zorya-Mashproekt UGT-15000+.

Contractors

Prime

Rolls-Royce, Energy Systems Inc	http://www.rolls-royce.com/energy, 105 N Sandusky St, Mount Vernon, OH 43050 United States, Tel: + 1 (740) 393-8888, Fax: + 1 (740) 393-8336, Prime
Kawasaki Heavy Industries, (KHI), Gas Turbine Division, Akashi Works	http://global.kawasaki.com/en/corp/profile/division/gasturbine/, 1-1 Kawasaki-cho, Akashi , Hyogo, Japan, Tel: + 81 78 921 1301, Fax: + 81 78 924 8654, Licensee
Rolls-Royce, Energy	http://www.rolls-royce.com/energy/, Ansty, Coventry, United Kingdom, Tel: + 44 24 7662 4919, Fax: + 44 24 7662 3977, Second Prime

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Subcontractor

Cameron Iron Works Ltd	Houstoun Rd, Livingston, West Lothian, United Kingdom, Tel: + 44 050631122, Fax: + 44 0314591901 (Forgings)
Caparo Accles and Pollock	http://www.caparoacclesandpollock.com, PO Box 14, Rood End Rd, Oldbury, West Midlands, United Kingdom, Tel: + 44 121 543 5765, Fax: + 44 121 543 5721 (Pressure Tube System)
Chromalloy France	http://www.chromalloy.com, Ave des Gros-Chevaux, Z.I. du Vert Galant, Saint Ouen l'Aumone, France, Tel: + 33 1 3440 3636, Fax: + 33 1 3421 9737, Email: info@chromalloy.fr (HP Blade; LP Blade)
Honeywell Aerospace Yeovil	http://www.honeywell.com, Bunford Ln, Yeovil, Somerset, United Kingdom, Tel: + 44 1935 457 181, Fax: + 44 1935 427 600, Email: sales.yeovil@honeywell.com (Fuel-Cooled Hydraulic Oil Cooler)
MB Aerospace Ltd, Burnley Engineering Products Ltd	http://www.motherwellbridge.com, Heasandford Industrial Estate, Unit 7, Burnley, United Kingdom, Tel: + 44 1282 446600, Fax: + 44 1282 439318 (Base Frame)
Microfiltrex Ltd	http://www.faireymicrofiltrex.com, Standard Way, Fareham Industrial, Fareham, Hants, United Kingdom, Tel: + 44 1329 285616, Fax: + 44 1329 822422, Email: les.lee@faireymicrofiltrex.co.uk (Fuel Filter Element)
Royal Schelde Group, Royal Schelde	http://www.schelde.com, Glacisstraat 165, PO Box 16, Vlissingen, Netherlands, Tel: + 31 118 485 000, Fax: + 31 118 485 050 (Gearbox)
UTC Aerospace Systems, Electric Systems	http://utcaerospacesystems.com, 4747 Harrison Ave, Rockford, IL 61108-7929 United States, Tel: + 1 (815) 226-6000 (Integrated Drive Generator; Cartridge & Pneumatic Starter)
VT Group plc	Woolston Shipyard, Victoria Rd, Woolston, Southampton, United Kingdom (Control)

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Technical Data

Dimensions.

	Metric Units	U.S. Units
Length	7.5 m	24.6 ft
Width	2.285 m	7.5 ft
Height	3.39 m	11.12 ft
Weight: Spey Module Complete, Dry (a)	25.7 tonnes	56,658 lb
Weight: Gas Generator Only	1.8 tonnes	3,968 lb

(a) Includes gas generator.

Performance.

R-R MARINE SPEY SM1C MODULE

	ISO Base Load Rating (Continuous)	Heat Rate (LHV)	SFC (LHV)	Intake Mass Flow	Exhaust Mass Flow	EGT
Metric Units	19.5 MW	9,603 kJ/kWh	225.6 g/kWh	66.67 kg/sec	66.9 kg/sec	458°C
U.S. Units	26,150 shp	6,789 Btu/shp-hr	0.371 lb/hp-hr	147.0 lb/sec	147.5 lb/sec	856°F

Design Features

Intake. An annular air plenum is fitted to the front of the engine. Compressor bleed air is used for anti-icing.

Compressor. A five-stage LP compressor is driven independently and is fitted with titanium alloy rotor blades, 12 percent Cr stator vanes, titanium alloy Stage 1-2 discs, 12 percent Cr steel Stage 3-5 discs, and aluminum alloy casing. It has an 11-stage HP compressor with Ti alloy rotor blades for Stages 1-8, 12 percent Cr steel rotor blades in Stages 9-11,

12 percent Cr steel for stator vanes and Stage 1-10 discs, and IN901 for the Stage 11 disc. Pressure ratio is 21.9 for the SM1C; intake mass flow is 66.7 kg/sec; exhaust mass flow is 66.9 kg/sec. Power turbine shaft speed is 5,500 rpm.

Combustor. Ten interconnected Nimonic cannular combustors, each with a multifuel nozzle at the burner head. Location faces are hard-faced to reduce fretting. Casing in 12 percent Cr steel, liner in Nimonic.

Turbines. The LP compressor is driven by a two-stage turbine. LP blades are Nimonic 105, discs are Nimonic 901, and vanes are Cr-Co-Mo steel. HP blades are Nimonic 108 and MAR-M002, discs are Nimonic 901, and vanes are in Stellite 31 and Ni-Cr-Co-Mo steel. HP turbine is a two-stage unit with cooled Stage 1 vanes and blades; LP turbine has Stage 1 vane cooling. I&M Speys have an independent power turbine, usually mounted on a skid that remains in place when the gas generator is removed. A two-stage PT is normally used with an overspeed trip protection system (unless specified otherwise).

Bearings. The R-R squeeze film technique is used to suppress compressor vibration by applying high-pressure oil to the area between the outer race and the casing. The rear turbine bearing is mounted in a snubbed spring housing to minimize out-of-balance forces.

Accessories. Woodward electric governors and fuel metering systems have been used. The Marine Spey is started using an air-start motor. The Marine Spey module has a self-contained gas generator lubricating oil system, cooler, and filters.

Operational Characteristics

The SM1 module is a complete marine propulsion package offered for naval surface vessels. It comprises a Marine Spey gas generator, an acoustic enclosure, a cascade air inlet bend, ancillary systems, electrical power points, and fire protection systems, all mounted in a fabricated steel baseplate. It incorporates its own local control facility and can be connected to alternative remote-control systems from the ship control center. The package includes heat and noise insulation, a self-contained ventilation system, and NBC protection.

Variants/Upgrades

Marine Spey Engine

Spey SM1A. The Spey SM1A gas generator is the basic model of the Marine Spey. It is rated at 12.75 MW (17,100 shp); max power output is 14 MW (18,770 shp).

Spey SM1C. The Spey SM1C gas generator is the first uprate of the SM1A; it is currently rated at approximately 19.5 MW (26,150 shp) continuous. This model incorporates the latest technology from the Tay aero engine.

(Allison) Model 1220-B2. Rolls-Royce, with then-Allison (now a wholly owned entity of Rolls-Royce), worked on an intercooled/regenerative-cycle Spey called the Model 1220-B2.

Aviation Spey Engine. More than 4,200 military and commercial Spey engines and over 1,400 license-built TF41 Spey derivative engines have been built. The aero Spey production run ended in 1996; the TF41 production run ended in 1982.

Licensees/Packagers. Several firms have included the Spey in their product lines, as follows:

Cooper Rolls Inc. Cooper Rolls (CR) was a company formed by Cooper Energy Services and Rolls-Royce to package and market several models in the Rolls-Royce line of gas turbines. Under the designation Coberra 3000 series, the Spey was packaged as the Coberra 3145, mating the Spey gas generator with a Cooper-Bessemer two-stage RT45 power turbine. Total power of the package is 12.5 MW. CR first installed a Spey in 1978 when N.V. Gasunie of the Netherlands ordered a compression set. That sale followed a trial installation on the TransCanada Pipeline for performance evaluation; the unit is still in operation there. TransCanada followed with a two-unit order, with installation in 1982. Westcoast Transmission (Canada) ordered four units, which became operational in 1982. In the United States, Northern Natural Gas installed a single compression set in North Dakota.

In 1989 it was announced that Cooper Rolls had dropped the Coberra 3000 series machines from its mechanical drive and power generation product line. The move left CR with the Coberra 2000, which uses the Industrial Avon, and the Coberra 6000, which uses the Industrial RB211 gas generator.

At least 14 I&M Spey gas turbine machines were installed, of which 12 are in operation.

GEC. GEC (General Electric Company of the U.K.) was a packager of the R-R gas generator line, including the Spey derivative. Designated ESP-1, the Spey-powered package was a high-efficiency unit that competed with the Avon-powered packages.

Dresser-Rand Company, Turbo Products Division. Similar to GEC and Cooper, D-R was designated a packager of the Rolls-Royce line, and incorporated the

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Spey as the GT-55 system. The firm is well known in the mechanical drive sector of the industry and continues to make use of the fuel-efficient gas generators.

Kawasaki Heavy Industries. Kawasaki Heavy Industries Ltd (KHI), Industrial Gas Turbine Division, Hyogo, Japan, has installed 80 Spey gas turbines in several types and classes of surface vessels for the Japan Maritime Self-Defense Force (Japanese Navy).

Program Review

Background. The Rolls-Royce plc I&M Spey (RB244) gas generator evolved from the Spey aviation turbofan. After a review of the variations of the aero Spey, Rolls-Royce decided to develop the RB168-66, an engine with a compact design, efficient performance, and a proven reliability record. Development of the non-aero Spey began in 1974.

The requirements for a high-efficiency marine gas turbine of 10 to 12 MW output had been identified, particularly for naval craft. Previous major British gas turbine warships had used the highly economical Tyne gas turbine for cruise power, while boost for maximum speed was provided by the powerful Olympus. In many ways, this combination provided the optimum technical solution for warship propulsion. The problems that developed in service reflected the maintenance and logistics issues that surrounded having two different gas turbines on the ships, resulting in duplication of spares holdings and technical expertise.

The new gas turbine was intended to replace the Tyne and Olympus with four identical engines with more or less the same total power. This represented a triumph of logistics over theoretical capability. The adaptation and development of a marine version of the Rolls-Royce Spey aero engine was funded by the Ministry of Defence to meet this requirement. Investigations showed that the most suitable version of the engine for conversion to the industrial and marine configuration was the TF41 developed by Rolls-Royce for the A-7 Corsair II attack aircraft.

Major changes to create the industrial variant included blanking off the fan bypass annulus, installing a new LP compressor casing, and modifying the fuel/combustor system to accommodate gaseous fuels. While most Industrial Speys are designed for gaseous fuels, the marine variant incorporates improved liquid fuel nozzles called Reflex Airspray Burners (RABs) that offer specific fuel consumption (SFC) improvements of up to 20 percent over other marine gas turbine power plants in its power class.

The Industrial Spey went into gas-pumping operation on the TransCanada Pipeline in 1976, and is in service in the energy industry in Europe. In 1988, the first Industrial Spey SK15HEs were delivered to the People's Republic of China.

Rolls-Royce received a marketing boost when six Spey units were ordered by China in 1985. Five of those units were destined for cogeneration electrical installations, while the sixth was destined for a gas compressor installation. The six units were viewed at that time as the possible beginning of a long association with China for engines spanning the gamut from aero to marine to industrial models. Given the vast potential of China in the oil, natural gas, and electric power markets, some industry observers believed the Spey could become an integral machine in the further development of the country's power infrastructure, especially in power generation packages.

Commercial Marine Spey Applications. Twin SM1A modules were installed in the Australian International Catamaran (INCAT) 110-meter passenger-carrying ferry, the *Wavepiercer*. The SM1As develop in excess of 17,100 shp.

Funding

The original aero Spey engine was privately developed by Rolls-Royce, although military funding and sponsorship by the U.K. Ministry of Defence followed. The I&M Spey machine was developed privately by Rolls-Royce. The Marine Spey SM1A and SM1C modules are built to U.K. MoD requirements.

Contracts/Orders & Options

Contractor	Award ($ millions)	Date/Description
Rolls-Royce	17.0	May 1984 – Royal Schelde contract for the supply of Marine Spey gas turbines to be manufactured at Rolls-Royce's Coventry, England, plant. The engines are for the Royal Netherlands Navy's Karel Doorman class of multipurpose frigates.
Rolls-Royce	N/A	Jul 2015 – Long-term service agreement with RWG for maintenance support of Marine Spey SM1A and SM1C gas turbines. This agreement is for through-life support of this equipment, including the repair and overhaul of gas turbine change units, engine modules, and line replacement units.

N/A = Not Available

Timetable

Month	Year	Major Development
	1959	Design of RB163 Spey aero engine
Oct	1961	First flight of aero Spey
Jan	1962	First flight of Spey-powered Hawker Siddeley Trident
Dec	1972	Study of Marine Spey begun
	1974	Development of non-aero Spey begun
2Q	1975	Industrial Spey becomes available
4Q	1976	First Industrial Spey enters service in Canada; SM1A module design completed
	1978	Cooper Rolls installs Coberra 3145 for Gasunie
	1981	Speys ordered for Type 22 and Japanese DDG vessels
	1982	First Industrial Speys enter service in U.S.
4Q	1983	First production-standard SM1As delivered
Nov	1985	Spey ICR contract awarded
Sep	1987	Spey SM1C gas generator first run
	1989	Cooper Rolls drops Coberra 3000 from its product offerings
Mar	1996	Contract let for the Netherlands Navy for first two new frigates
Into	2006	Production ends

Worldwide Distribution/Inventories

Marine Spey Applications

Country	Class	Spey Turbines per Ship	Number
Belgium	Karel Doorman (2)	2	4
Chile	Karel Doorman (2)	2	4
Chile	Type 23 (3)	2	6
Japan	Akizuki (4)	4	16
Japan	Murasame (9)	2	18
Japan	Takanami (5)	2	10
Japan	Hatakaze (2)	2	4
Japan	Asagiri (8)	4	32
Japan	Abukuma (6)	2	12
Japan	Mashuu (2)	2	4
Japan	Kashima (1)	2	2
Netherlands	Karel Doorman (2)	2	4
Netherlands	De Zeven Provincien (4)	2	8
Portugal	Karel Doorman (2)	2	4
United Kingdom	Type 23 (13)	2	26
United Kingdom	Type 22 Batch 3 (4)	2	8
United Kingdom	Type 22 Batch 2 (1)	2	2
Total			**164**

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Land-based Spey Applications

Country	Date Installed	Number
Canada	1976 (1), 1980 (1), 1981 (6), 1982 (1), 1988 (2)	11
China	1987 (3), 1988 (2)	5
Netherlands	1978	1
United States	1986 (1), 2002 (1)	2
Total		**19**

Forecast Rationale

The Rolls-Royce I&M Spey is almost entirely a marine gas turbine, with less than 10 percent of production going to land-based applications. It appears that no Industrial Speys have been sold for over a decade. Marine Spey sales were restricted to Japan, the Netherlands and the U.K., with other nations later acquiring the gas turbine via the purchase of surplus warships.

The primary user of this marine gas turbine has been the Japan Maritime Self-Defense Force. Of the 164 Marine Speys that have been produced, 96 have been installed in its ships. The JMSDF was also the last navy to specify the Spey as the powertrain for one of its warships.

For the new 25DD class of ASW destroyers, the JMSDF has adopted a CODLAG configuration coupling a diesel-electric powertrain with two LM2500+PG4 gas turbines. It is not clear at this time if the gas turbines will drive generators as well.

With the decision by the Japanese to adopt other power solutions, there are no outstanding warship construction programs that offer an opportunity for the Spey. This gas turbine has reached the end of its production life and, unless there is a significant change in the market, this report will be archived next year.

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